We claim:

1. A chemical processing microsystem comprising

four or more microreactors formed in a plurality of adjacent laminae, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction of interest, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each of the four or more microreactors and for discharging a reactor effluent from the outlet port of each of the four or more microreactors to one or more external effluent sinks,

at least one of the plurality of laminae being a material-containing laminate that forms a portion of the cavity-defining surface of the four or more microreactors, the material-containing laminate comprising a substrate and at least four materials arranged on the substrate such that they are individually resident in the reaction cavities of the four or more microreactors,

the four or more microreactors being accessible for loading the material-containing laminate prior to carrying out the chemical reaction of interest, and for unloading the material-containing laminate after the chemical reaction of interest.

2. The microsystem of claim 1 further comprising a releasable seal between the material-containing laminate and one or more adjacent laminae in which the microreactors are formed.

3. The microsystem of claim 2 wherein the releasable seal is a gasket.

4. The microsystem of claim 2 wherein the releasable seal is a graphite gasket.

5. The microsystem of claim 1 wherein the microsystem comprises

a first laminate having first and second surfaces in spaced, substantially parallel relationship to each other, and an array of the at least four materials,

a second laminate having a first surface in releasable contact with the second surface of the first laminate, a second surface in spaced, substantially parallel relationship

to the first surface, and an array of four or more wells defined by interior edges of the first surface of the second laminate and by interior surfaces of the second laminate, the array of wells having an arrangement that corresponds to the array of at least four materials formed in the first laminate, such that taken together, the first and second laminates form an array of four or more material-containing microreactors.

6. The chemical processing microsystem of claim 1 wherein the microsystem comprises

a first laminate having first and second surfaces in spaced, substantially parallel relationship to each other, and an array of the at least four materials,

a releasable seal adjacent the second surface of the first laminate,

a second laminate having a first surface adjacent the releasable seal, a second surface in spaced, substantially parallel relationship to the first surface, and an array of four or more apertures defined by interior edges and interior surfaces of the second laminate, and

a third laminate having a first surface bonded to the second surface of the second laminate such that, taken together, the second and third laminates form a composite substructure comprising an array of four or more wells defined by the interior edges and interior surfaces of the second laminate and those portions of the first surface of the third laminate circumscribed by such interior edges,

the array of wells formed in the composite substructure having an arrangement that corresponds to the array of the at least four materials of the first laminate, such that taken together, the first, second and third laminates form an array of four or more material-containing microreactors.

7. A chemical processing microsystem comprising

four or more microreactors formed in a plurality of adjacent laminae, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction of interest, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each of the four or more microreactors and for discharging a reactor effluent from the outlet port of each of the four or more

microreactors to one or more external effluent sinks,

at least one of the plurality of laminae being a material-containing laminate that forms a portion of the cavity-defining surface of the four or more microreactors, the material-containing laminate comprising a substrate and at least four materials arranged on the substrate such that they are individually resident in the reaction cavities of the four or more microreactors, the material-containing laminate having an essential absence of fluid distribution components.

8. The microsystem of claim 7 wherein the material-containing laminate further has an essential absence of temperature control components.

9. The microsystem of claim 7 wherein the material-containing laminate consists essentially of the substrate and the at least four materials.

10. The microsystem of claim 7 wherein the material-containing laminate consists of the substrate and the at least four materials.

11. The microsystem of claim 7 wherein the microreactors are substantially coplanar with each other.

12. The microsystem of claim 7 wherein the at least one surface of the material-containing laminate is in releasable contact with a surface of adjacent laminae in which the microreactors are formed.

13. The microsystem of claim 7 further comprising a releasable seal between the material-containing laminate and one or more adjacent laminae in which the microreactors are formed.

14. A chemical processing microsystem comprising

four or more microreactors, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction of interest, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity,

a film of material on at least a portion of the surface defining the reaction cavity

of each of the four or more microreactors, the material being selected from the group consisting of inorganic materials, metal-ligand materials and non-biological organic materials, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each of the four or more microreactors and for discharging a reactor effluent from the outlet port of each of the four or more microreactors to one or more external effluent sinks.

15. The chemical processing microsystem of claim 14 wherein at least four materials are individually resident as surface films in the four or more microreactors.

16. The chemical processing microsystem of claim 14 wherein the material film is formed by a method selected from physical vapor deposition, chemical vapor deposition, plasma-assisted chemical vapor deposition, electrodeposition, electrochemical deposition, coating techniques, or solution-based techniques.

17. The chemical processing microsystem of claim 14 wherein the material film is formed by solution-based techniques.

18. The chemical processing microsystem of claim 14 wherein the material film is formed by sol-gel techniques.

19. The chemical processing microsystem of claim 14 wherein the material film is prepared by a method that includes forming a film of a catalyst support material on at least a portion of the surface that can define the reaction cavity, and impregnating the catalyst support material with a catalyst or a catalyst precursor.

20. A chemical processing microsystem comprising

ten or more microreactors, each of the ten or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each reaction cavity and for discharging a

reactor effluent from the outlet port of each reaction cavity to one or more external effluent sinks, the distribution system comprising a manifold comprising one or more common ports adaptable for fluid communication with one or more external reactant sources or one or more external reactor effluent sinks, ten or more terminal ports adaptable for fluid delivery to or fluid recovery from the ten or more microreactors, and a distribution channel providing fluid communication between the one or more common ports and each of the ten or more terminal ports, the ratio of the number of terminal ports to the number of common ports being not less than about 10:1.

21. The microsystem of claim 20 comprising twenty or more microreactors wherein the ratio of the number of terminal ports to the number of common ports is not less than about 20:1.

22. The microsystem of claim 20 comprising thirty or more microreactors wherein the ratio of the number of terminal ports to the number of common ports is not less than about 30:1.

23. The microsystem of claim 20 comprising fifty or more microreactors wherein the ratio of the number of terminal ports to the number of common ports is not less than about 50:1.

24. The microsystem of claim 20 comprising one-hundred or more microreactors wherein the ratio of the number of terminal ports to the number of common ports is not less than about 100:1.

25. The microsystem of claim 20 wherein the fluid distribution system comprises a manifold having substantially the same resistance to flow between the one or more common ports and each of the ten or more terminal ports, such that the fluid distribution system provides substantially the same flow through each of the ten or more microreactors.

26. The microsystem of claim 20 comprising sixteen or more microreactors, wherein the fluid distribution manifold comprises
a common port adaptable for fluid communication with one or more fluid sources or

sinks,

2^n terminal ports adaptable for fluid delivery to or fluid recovery from 2^n microcomponents, n being an integer not less than 4, and

a distribution channel providing fluid communication between the common port and each of the 2^n terminal ports, the distribution channel having a hydraulic radius of not more than about 2.5 mm and comprising 2^n-1 channel sections connected with each other through 2^n-1 binary junctions, each of the 2^n-1 channel sections having at least three access ports serving as the common port, as a connection port for a binary junction, or as a terminal port.

27. The microsystem of claim 26 wherein the 2^n-1 channel sections are linear channel sections.

28. The microsystem of claim 26 wherein the ten or more microreactors are arranged in a substantially planar array with planar density of not less than about 1 microreactor / cm^2.

29. The microsystem of claim 20 wherein the ten or more microreactors are formed in a plurality of laminae.

30. The microsystem of claim 20 wherein the ten or more microreactors are formed in a plurality of laminae, and the fluid distribution manifold is formed in at least one laminate other than the laminae in which the ten or more microreactors are formed.

31. The microsystem of claim 20 wherein the chemical processing microsystem further comprises at least ten different candidate materials individually resident in the ten or more microreactors.

32. A chemical processing microsystem comprising

four or more microreactors, each of the four or more microreactors comprising a surface defining a reaction cavity for carrying out a chemical reaction, the reaction cavity having a volume of not more than about 3 ml and a geometry defined by ratios of distances X, Y, and Z measured within the reaction cavity along three mutually orthogonal lines having a common point of intersection at a midpoint of the longest line,

Z, the X:Z and Y:Z ratios each ranging from about 1:2 to about 1:1, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each of the four or more microreactors and for discharging a reactor effluent from the outlet port of each of the four or more microreactors to one or more external effluent sinks.

33. The microsystem of claim 32 wherein the volume of the reaction cavity is not more than about 1 μl.

34. The microsystem of claim 32 wherein the X:Z and Y:Z ratios each range from about 2:3 to about 1:1.

35. The microsystem of claim 32 wherein the X:Z and Y:Z ratios each range from about 3:4 to about 1:1.

36. The microsystem of claim 32 wherein the X:Z and Y:Z ratios are each about 1:1.

37. The microsystem of claim 32 wherein the chemical processing microsystem further comprises at least four different candidate materials individually resident in the four or more microreactors.

38. A chemical processing microsystem comprising

four or more microreactors, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, the volume of at least two of the four or more microreactors being different, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each reaction cavity and for discharging a reactor effluent from the outlet port of each reaction cavity to one or more external effluent sinks.

39. The chemical processing microsystem of claim 38 wherein the volume of at least four of the four or more microreactors is different.

40. A chemical processing microsystem comprising

four or more microreactors, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity, the four or more microreactors being arranged in a substantially planar array and having a planar density of not less than about 5 microreactors / cm^2, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each reaction cavity and for discharging a reactor effluent from the outlet port of each reaction cavity to one or more external effluent sinks.

41. The microsystem of claim 40 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 10 microreactors / cm^2.

42. The microsystem of claim 40 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 25 microreactors / cm^2.

43. The microsystem of claim 40 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 50 microreactors / cm^2.

44. The microsystem of claim 40 wherein the chemical processing microsystem further comprises at least four different candidate materials individually resident in the four or more microreactors.

45. A chemical processing microsystem comprising

four or more microreactors, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity,

a fluid supply system for supplying one or more reactants from one or more external reactant sources to the inlet port of each reaction cavity,

four or more microseparators, each of the four or more microseparators comprising a surface defining a separation cavity for separating at least one component of a reactor effluent, an inlet port in fluid communication with the outlet port of one of the microreactors for receiving the reactor effluent therefrom, and an outlet port in fluid communication with the separation cavity for discharging the separated effluent therefrom, and

a fluid discharge system for discharging a reactor effluent from the outlet port of each separation cavity to one or more external effluent sinks.

46. The microsystem of claim 45 wherein the chemical processing microsystem further comprises at least four different candidate materials individually resident in the four or more microreactors.

47. The microsystem of claim 45 wherein the microseparators further comprise an adsorbent material that is substantially selective to a reaction product of interest.

48. The microsystem of claim 45 wherein the microseparators are formed in a plurality of adjacent laminae, at least one of the laminae being an adsorbent-containing laminate comprising a substrate and one or more adsorbent materials for adsorbing at least one component of the reactor effluent, the microsystem further comprising a releasable seal between the adsorbent-containing laminate and one or more adjacent laminae in which the microseparators are formed.

49. The microsystem of claim 45 wherein the four or more microreactors are formed in a plurality of laminae and the four or more microseparators are formed in a plurality of laminae.

50. The microsystem of claim 45 wherein the four or more microreactors are formed in a plurality of adjacent laminae, at least one of the laminae being a candidate material-containing laminate comprising a substrate and the at least four candidate materials at separate portions of the substrate, and the four or more microseparators are formed in a plurality of adjacent laminae, at least one of the laminae being an adsorbent-

containing laminate comprising a substrate and one or more adsorbent materials for adsorbing at least one component of the reactor effluent.

51. The microsystem of claim 45 wherein the four or more microreactors are formed in a first plurality of laminae and the four or more microseparators are formed in a second plurality of laminae, the microsystem further comprising a temperature control block between the first plurality of laminae and the second plurality of laminae.

52. The microsystem of claim 45 wherein the four or more microreactors and the four or more microseparators are formed in a common plurality of laminae.

53. The microsystem of claim 45 wherein each of the four or more microreactors are substantially coplanar with each other and each of the four or more microseparators are substantially coplanar with each other.

54. The microsystem of claims 1, 7, 14, 20, 32, 40 or 45 wherein the reaction cavity has a volume of not more than about 100 µl.

55. The microsystem of claims 1, 7, 14, 20, 32, 40 or 45 wherein the reaction cavity has a volume of not more than about 10 µl.

56. The microsystem of claims 1, 7 or 15 wherein the at least four materials are at least four different materials.

57. The microsystem of claims 1 or 7 wherein the at least four materials are selected from the group consisting of inorganic materials, metal-ligand materials and non-biological organic materials.

58. The microsystem of claims 20, 32, 40 or 45 further comprising at least four different candidate materials individually resident in the reaction cavities of the four or more microreactors, the at least four candidate materials being selected from the group consisting of inorganic materials, metal-ligand materials and non-biological organic materials.

59. The microsystem of claims 1, 7, 14, 20, 32, 40 or 45, comprising one-hundred or more microreactors and at least one-hundred different candidate materials individually resident in the reaction cavities of the one-hundred or more microreactors, the at least one-hundred candidate materials being selected from the group consisting of inorganic materials, metal-ligand materials and non-biological organic materials.

60. The microsystem of claims 1, 7, 14, 20, 32 or 45 wherein the microreactors are arranged in a substantially planar array with planar density of not less than about 1 microreactor / cm^2.

61. A chemical processing microsystem comprising

two-hundred-fifty or more microreactors, each of the two-hundred-fifty or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 10 μl for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity,

at least four materials individually resident in the reaction cavity of separate microreactors, each of the materials comprising an inorganic material, a metal-ligand or a non-biological organic material, and

a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the inlet port of each reaction cavity and for discharging a reactor effluent from the outlet port of each reaction cavity to one or more external effluent sinks.

62. The microsystem of claim 61 wherein the reaction cavity of each of the two-hundred-fifty or more microreactors has a volume of less than about 10 μl.

63. The microsystem of claim 61 wherein the reaction cavity of each of the two-hundred-fifty or more microreactors has a volume of not more than about 5 μl.

64. The microsystem of claim 61 wherein the reaction cavity of each of the two-hundred-fifty or more microreactors has a volume of not more than about 1 μl.

65. The microsystem of claim 61 wherein the amount of the candidate material in

each of the candidate-material containing microreactors is not more than about 5 mg.

66. The microsystem of claim 61 wherein the amount of the candidate material in each of the candidate-material containing microreactors is not more than about 1 mg.

67. The microsystem of claim 61 wherein the candidate material comprises an inorganic material.

68. The microsystem of claim 61 wherein the candidate material comprises a metal-ligand.

69. The microsystem of claim 61 wherein the candidate material comprises a non-biological organic material.

70. The microsystem of claim 61 wherein the candidate material consists essentially of elements or compounds selected from the group consisting of an inorganic material, a metal-ligand and a non-biological organic material.

71. The microsystem of claim 61 wherein the candidate material is a film of material formed on a surface of the reaction cavity.

72. The microsystem of claim 61 comprising four-hundred or more microreactors.

73. The microsystem of claim 61 comprising one-thousand or more microreactors.

74. The microsystem of claim 61 wherein the at least four materials are at least four different materials.

75. The microsystem of claim 61 wherein at least eight different candidate materials are individually resident in the reaction cavities of separate microreactors.

76. The microsystem of claim 61 wherein at least fifty different candidate

materials are individually resident in the reaction cavities of separate microreactors.

77. The microsystem of claim 61 wherein at least two-hundred-fifty different candidate materials are individually resident in the reaction cavities of separate microreactors.

78. The microsystem of claim 61 wherein different candidate materials are individually resident in the reaction cavities of at least 90% of the microreactors.

79. The microsystem of claim 61 wherein the reaction cavities have a volume that is substantially the same for each of the microreactors.

80. The microsystem of claim 61 wherein the reaction cavities have a volume that is different for at least two of the microreactors.

81. The microsystem of claim 61 wherein the fluid distribution system consists of passive microcomponents.

82. The microsystem of claim 61 further comprising an analytical detection system in fluid communication with the outlet port of one or more of the microreactors.

83. The microsystem of claim 61 wherein each of the two-hundred-fifty or more microreactors is accessible for loading candidate catalyst materials prior to carrying out the chemical reaction of interest and for unloading materials after the chemical reaction of interest.

84. The microsystem of claim 61 wherein a portion of the reaction cavity-defining surface of each of the two-hundred-fifty or more microreactors is formed by a material-containing laminate comprising a substrate and the at least four materials at separate portions of the substrate.

85. The microsystem of claim 61 wherein the microreactors are formed in a plurality of adjacent laminae.

86. The microsystem of claim 61 wherein the microreactors are formed in a plurality of adjacent laminae, at least one of the laminae being a material-containing laminate comprising a substrate and the at least four materials at separate portions of the substrate, the microsystem further comprising a releasable seal between the material-containing laminate and one or more adjacent laminae in which the microreactors are formed.

87. The microsystem of claim 61 wherein the microreactors are formed in a plurality of adjacent laminae, at least one of the laminae being a material-containing laminate comprising a substrate and the at least four materials at separate portions of the substrate, the material-containing laminate having an essential absence of fluid distribution components.

88. The microsystem of claim 61 wherein the microreactors are formed in a plurality of adjacent laminae, at least one of the laminae being a material-containing laminate comprising a substrate and the at least four materials at separate portions of the substrate, the material-containing laminate having an essential absence of temperature control components.

89. The microsystem of claim 61 wherein the fluid distribution system comprises a manifold comprising at least one common port adaptable for fluid communication with one or more external reactant sources or one or more external reactor effluent sinks, two-hundred-fifty or more terminal ports adaptable for fluid delivery to or fluid recovery from the two-hundred-fifty or more microreactors, and a distribution channel providing fluid communication between the at least one common port and each of the two-hundred-fifty or more terminal ports, the ratio of the number of terminal ports to the number of common ports being not less than about 10:1.

90. The microsystem of claim 89 wherein the ratio of the number of terminal ports to the number of common ports is not less than 100:1.

91. The microsystem of claim 89 wherein the ratio of the number of terminal ports to the number of common ports is not less than 200:1.

92. The microsystem of claim 61 wherein the fluid-distribution system comprises a fluid distribution manifold comprising a common port adaptable for fluid communication with one or more external reactant sources or one or more external effluent sinks,

2^n terminal ports adaptable for fluid delivery to or fluid recovery from 2^n microreactors, n being an integer not less than 4, and

a distribution channel providing fluid communication between the common port and each of the 2^n terminal ports, the distribution channel comprising 2^n-1 channel sections connected with each other through 2^n-1 binary junctions, each of the 2^n-1 channel sections having at least three access ports serving as the common port, as a connection port for a binary junction, or as a terminal port.

93. The microsystem of claim 92 wherein each of the channel sections are linear.

94. The microsystem of claim 92 wherein n is an integer of not less than 6.

95. The microsystem of claim 92 wherein n is an integer of not less than 8.

96. The microsystem of claim 92 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 1 microreactor / cm^2.

97. The microsystem of claim 61 wherein the reaction cavity of each of the two-hundred-fifty or more microreactors has a geometry defined by ratios of distances X, Y, and Z measured within the reaction cavity along three mutually orthogonal lines having a common point of intersection at a midpoint of the longest line, Z, the X:Z and Y:Z ratios each ranging from about 1:2 to about 1:1.

98. The microsystem of claim 97 wherein the X:Z and Y:Z ratios each range from about 2:3 to about 1:1.

99. The microsystem of claim 97 wherein the X:Z and Y:Z ratios each range from about 3:4 to about 1:1.

100. The microsystem of claim 61 wherein the microreactors are arranged in a

substantially planar array with a planar density of at least 1 microreactor/cm^2.

101. The microsystem of claim 61 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 5 microreactors / cm^2.

102. The microsystem of claim 61 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 10 microreactors / cm^2.

103. The microsystem of claim 61 wherein the microreactors are arranged in a substantially planar array with a planar density of at least 5 microreactors / cm^2 and the reaction cavity of each of the two-hundred-fifty or more microreactors has a volume of not more than about 1 µl.

104. The microsystem of claim 61 further comprising two-hundred-fifty or more microseparators, each of the two-hundred-fifty or more microseparators comprising a surface defining a separation cavity for separating at least one component of the reactor effluent, an inlet port in fluid communication with the outlet port of one of the microreactors for receiving the reactor effluent therefrom, and an outlet port in fluid communication with the separation cavity for discharging the separated effluent therefrom.

105. The microsystem of claim 104 wherein the microseparators further comprise an adsorbent material.

106. The microsystem of claim 104 wherein the microseparators are formed in a plurality of adjacent laminae, at least one of the laminae being an adsorbent-containing laminate comprising a substrate and one or more adsorbent materials for adsorbing at least one component of the reactor effluent, the microsystem further comprising a releasable seal between the adsorbent-containing laminate and one or more adjacent laminae in which the microseparators are formed.

107. The microsystem of claim 61 wherein

the two-hundred-fifty or more microreactors are formed in a plurality of adjacent laminae and are arranged in a substantially planar array with a planar density of at least

about 1 microreactor / cm^2, at least one of the laminae being a material-containing laminate comprising a substrate and at least eight different candidate materials at separate portions of the substrate, the material-containing laminate having an essential absence of fluid distribution components,

the fluid distribution system comprises a manifold comprising at least one common port adaptable for fluid communication with one or more external reactant sources or one or more external reactor effluent sinks, two-hundred-fifty or more terminal ports adaptable for fluid delivery to or fluid recovery from the two-hundred-fifty or more microreactors, and a distribution channel providing fluid communication between the at least one common port and each of the two-hundred-fifty or more terminal ports, the ratio of the number of terminal ports to the number of common ports being not less than about 10:1.

108. The microsystem of claim 107 further comprising a releasable seal between the material-containing laminate and one or more adjacent laminae in which the microreactors are formed.

109. The microsystem of claim 107 wherein the reaction cavity of each of the two-hundred-fifty or more microreactors has a geometry defined by ratios of distances X, Y, and Z measured within the reaction cavity along three mutually orthogonal lines having a common point of intersection at a midpoint of the longest line, Z, the X:Z and Y:Z ratios each ranging from about 1:2 to about 1:1.

110. The microsystem of claim 107 further comprising two-hundred-fifty or more microseparators formed in a plurality of adjacent laminae, at least one of the laminae being an adsorbent-containing laminate comprising a substrate and one or more adsorbent materials for adsorbing at least one component of the reactor effluent, each of the two-hundred-fifty or more microseparators comprising a surface defining a separation cavity for separating at least one component of the reactor effluent, an inlet port in fluid communication with the outlet port of one of the microreactors for receiving the reactor effluent therefrom, and an outlet port in fluid communication with the separation cavity for discharging the separated effluent therefrom.

111. A system for identifying and characterizing materials that enhance a chemical

reaction, the system comprising

a chemical processing microsystem comprising (i) a plurality of parallel microreactors for carrying out a chemical reaction of interest, (ii) a plurality of parallel microseparators, each of the plurality of microseparators comprising an adsorbent material that is selective for one or more reaction products of interest, and (iii) a fluid distribution system for supplying one or more reactants from one or more external reactant sources to the plurality of microreactors, for transferring reactor effluent from the plurality of microreactors to the plurality of microseparators, and for discharging the separated effluent from the microseparators,

a station for applying a detection agent to the adsorbent material such that the detection agent can react with the one or more adsorbed reaction products to form a detectable species, and

a detector for detecting the detectable species.

112. The system of claim 111 wherein the detection agent is a dye or colorant.

113. The system of claim 111 wherein the station is a spray station.

114. The system of claim 111 wherein the detector is a parallel detector.

115. The system of claim 111 wherein the detector is a CCD camera.

116. A method for providing materials to a parallel processing microsystem for identifying and characterizing materials that enhance a chemical reaction, the method comprising

simultaneously loading at least four materials into four or more microreactors such that the materials are individually resident in a reaction cavity of a separate microreactor, each of the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity for supplying one or more reactants to the reaction cavity, and an outlet port in fluid communication with the reaction cavity for discharging a reactor effluent from the reaction cavity.

117. The method of claim 116 wherein at least ten materials are simultaneously loaded into ten or more microreactors.

118. The method of claim 116 wherein at least one-hundred materials are simultaneously loaded into one-hundred or more microreactors.

119. The method of claim 116 wherein the four or more microreactors are formed in a plurality of laminae and the at least four materials are loaded into the four or more microreactors as a material-containing laminate comprising a substrate and the at least four materials at separate portions of the substrate.

120. The method of claim 116 wherein the four or more microreactors are formed in a plurality of laminae, the plurality of laminae including

a first laminate comprising first and second surfaces in spaced, substantially parallel relationship to each other and the at least four materials,

a second laminate or laminates comprising first and second surfaces in spaced, substantially parallel relationship with each other, and an array of four or more substantially coplanar wells arranged to correspond to the arrangement of the at least four materials of the first laminate, each of the wells having an interior surface defining an open-ended cavity at the first surface, the method further comprising

engaging the second surface of the materials-containing first laminate and the first surface of the second laminate such that, taken together, the engaged laminae form an array of four or more microreactors defined by the interior surfaces of the wells and at least a portion of material-containing regions of the material-containing first laminate.

121. The method of claim 120 wherein the second surface of the materials-containing first laminate and the first surface of second laminate are releasably engaged.

122. The method of claim 120 wherein the second surface of the materials-containing first laminate and the first surface of second laminate are bonded.

123. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

simultaneously loading at least four materials into four or more microreactors of a chemical processing microsystem such that the at least four materials are individually resident in separate microreactors, each of the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the four or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the four or more microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from each of the four or more material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest.

124. The method of claim 123 wherein the amount of each of the at least four materials loaded into the microreactors is not more than about 5 mg.

125. The method of claim 123 wherein the amount of each of the at least four materials loaded into the microreactors is not more than about 1 mg.

126. The method of claim 123 wherein at least ten materials are simultaneously loaded into ten or more microreactors.

127. The method of claim 123 wherein at least one-hundred materials are simultaneously loaded into one-hundred or more microreactors.

128. The method of claim 123 wherein the at least four materials are simultaneously loaded into the four or more microreactors as an array of candidate materials, the array comprising a substantially planar substrate and four or more materials at separate portions of the substrate.

129. The method of claim 123 further comprising simultaneously unloading the

reactant-contacted materials from the microreactors in which they reside after the chemical reaction of interest.

130. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into four or more microreactors formed in a plurality of laminae such that the at least four materials are individually resident in separate microreactors, each of the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the four or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the four or more microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from each of the four or more material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest,

the at least four materials being loaded into the four or more microreactors without affecting the structural integrity of a fluid distribution system through which the one or more reactants are supplied to the microreactors or through which one or more reactor effluents are discharged from the microreactors.

131. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into four or more microreactors at a time t_1 such that the at least four materials are individually resident in separate microreactors, each of the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the four or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the four or more microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from each of the four or more material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest at a time t_2, the difference in time, t_1-t_2, being less than about 3 hours.

132. The method of claim 131 wherein the difference in time, t_1-t_2, is not more than about 1 hr.

133. The method of claim 131 wherein the difference in time, t_1-t_2, is not more than about 30 minutes.

134. The method of claim 131 wherein the difference in time, t_1-t_2, is not more than about 15 minutes.

135. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least ten materials into ten or more microreactors such that the at least ten materials are individually resident in separate microreactors, each of the at least ten materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the ten or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the ten or more microreactors,

simultaneously contacting each of the at least ten materials with the one or more reactants in the ten or more microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from each of the ten or more material-containing microreactors, and

evaluating the at least ten materials for catalytic activity for the chemical reaction of interest, the at least ten materials being evaluated for catalytic activity at a throughput of not less than about 10 materials / hour.

136. The method of claim 135 wherein the at least ten materials are evaluated for catalytic activity at a throughput of not less than about 100 materials / hour.

137. The method of claim 135 wherein the at least ten materials are evaluated for catalytic activity at a throughput of not less than about 1000 materials / hour.

138. The method of claim 135 wherein the at least ten materials are at least ten different materials.

139. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into four or more microreactors such that the at least four materials are individually resident in separate microreactors, each of the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a geometry and having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the four or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the four or more microreactors,

selecting the geometry of the reaction cavity and controlling the reaction conditions in the four or more microreactors such that the reactant residence time, τ_{res}, is longer than the diffusion period, τ_{diff}, for the reaction cavity,

simultaneously discharging a reactor effluent from each of the four or more material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest.

140. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into four or more microreactors of a chemical processing microsystem such that the at least four materials are individually resident in separate microreactors, each of the at least four materials comprising an inorganic

material, a metal-ligand or a non-biological organic material, each of the four or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 10 μl,

simultaneously supplying one or more reactants to each of the four or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the four or more microreactors,

simultaneously discharging a reactor effluent from each of the four or more material-containing microreactors into separate four or more microseparators of the chemical processing microsystem,

simultaneously separating one or more components of the reactor effluents in the four or more microseparators, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest.

141. The method of claims 116, 123, 130, 131, 139 or 140 wherein the at least four materials are at least four different materials.

142. The method of claims 116, 123, 130, 131, 139 or 140 wherein the reaction cavity of each of the four or more material-containing microreactors has a volume of not more than about 100 μl.

143. The method of claims 116, 123, 130, 131, 139 or 140 wherein the reaction cavity of each of the four or more material-containing microreactors has a volume of not more than about ~~10 μl~~.

144. The method of claims 116, 123, 130, 131, 139 or 140 wherein the reaction cavity of each of the four or more material-containing microreactors has a volume of not more than about 1 μl.

145. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into two-hundred-fifty or more microreactors such that the at least four materials are individually resident in separate microreactors, each of

the at least four materials comprising an inorganic material, a metal-ligand or a non-biological organic material, each of the two-hundred-fifty or more microreactors comprising a surface defining a reaction cavity having a volume of not more than 3 ml,

simultaneously supplying one or more reactants to each of the two-hundred-fifty or more microreactors,

simultaneously contacting each of the at least four materials with the one or more reactants in the two-hundred-fifty or more microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from each of the two-hundred-fifty or more material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest.

146. The method of claim 145 further comprising

unloading the at least four reactant-contacted materials from the microreactors in which they reside, and

loading a second set of at least four materials into the four or more microreactors of the chemical processing microsystem such that the second set of at least four materials are individually resident in separate microreactors.

147. The method of claim 146 wherein the at least four candidate materials are loaded simultaneously into the four or more microreactors, and the reactant-contacted candidate materials are unloaded simultaneously therefrom.

148. The method of claim 146 wherein the at least four materials are loaded sequentially into the four or more microreactors, and the reactant-contacted candidate materials are unloaded therefrom.

149. The method of claim 146 wherein one or more of the steps of loading the at least four candidate materials into the four or more microreactors, unloading the reactant-contacted candidate materials from the microreactors, and loading a second set of at least four candidate materials into the four or more microreactors are automated.

150. The method of claim 145 wherein the one or more reactants are gaseous

reactants.

151. The method of claim 145 wherein the at least four materials are contacted with the one or more reactants under a set of reaction conditions, the method further comprising controlling the reaction conditions to be substantially the same in each of the two-hundred-fifty or more microreactors.

152. The method of claim 145 wherein the at least four candidate materials are contacted with the one or more reactants under a set of reaction conditions, the method further comprising controlling the reaction conditions to be substantially the same in each of the two-hundred-fifty or more microreactors according to one or more control protocols selected from the group consisting of:

controlling the temperature to be not less than about 100 °C and to be substantially the same in at least four of the two-hundred-fifty or more microreactors,

controlling the pressure to range from about 1 atm to about 200 bar and to be substantially the same in at least four of the two-hundred-fifty or more microreactors,

controlling the residence time to range from about 1 μsec about 1 hour and to be substantially the same in at least four of the two-hundred-fifty or more microreactors, and

controlling the reactant flow rate to be substantially the same through at least four of the two-hundred-fifty or more microreactors.

153. The method of claim 145 wherein the at least four materials are contacted with the one or more reactants under a set of reaction conditions, the method further comprising controlling the reaction conditions to be varied between at least two of the two-hundred-fifty or more microreactors.

154. The method of claim 145 wherein the at least four materials are contacted with the one or more reactants under a set of reaction conditions, the method further comprising controlling the reaction conditions to be varied between at least two of the two-hundred-fifty or more microreactors according to one or more control protocols selected from the group consisting of:

controlling the temperature to be varied between at least two of the two-hundred-fifty or more microreactors,

controlling the pressure to be varied between at least two of the two-hundred-fifty or more microreactors,

controlling the residence time to be varied between at least two of the two-hundred-fifty or more microreactors, and

controlling the reactant flow rate to be varied through at least two of the two-hundred-fifty or more microreactors.

155. The method of claim 145 wherein the candidate materials are a film of material formed on a surface of the reaction cavity.

156. The method of claim 145 wherein the microsystem comprises four-hundred or more microreactors.

157. The method of claim 145 wherein the microsystem comprises one-thousand or more microreactors.

158. The method of claim 145 wherein different candidate materials are individually resident in the separate reaction cavities of at least 90% of the two-hundred-fifty or more microreactors.

159. The method of claim 145 wherein at least four materials are evaluated for catalytic activity according to one or more analytical protocols selected from the group consisting of

determining catalytic activity by analytical measurement of the reactor effluent,

determining catalytic activity by *in situ* analytical measurement,

determining catalytic activity by serial analytical measurement,

determining catalytic activity by parallel analytical measurement, and

determining catalytic activity of a subset of the at least four materials by parallel analytical measurement.

160. The method of claim 145 wherein at least four materials are evaluated for catalytic activity according to one or more analytical protocols selected from the group consisting of

determining catalytic activity by parallel or serial gas chromatography of the

reactor effluents,

determining catalytic activity by separating one or more components of the reactor effluents and determining the presence, absence or amount of the separated one or more components,

determining catalytic activity by adsorbing one or more components of at least four reactor effluents onto an adsorbent material, and determining the presence, absence or amount of adsorbed component,

determining catalytic activity by adsorbing one or more components of at least four reactor effluents onto an adsorbent material, desorbing an adsorbed component, and determining the presence, absence or amount of desorbed component, and

determining catalytic activity by determining the amount of a reaction product formed by the chemical reaction of interest.

161. A method for identifying or optimizing catalysts for a chemical reaction of interest, the method comprising

loading at least four materials into the microreactors of the chemical processing microsystem of claims 1, 7, 14, 20, 32, 38, 40, 45 or 61,

simultaneously contacting each of the at least four materials with the one or more reactants in the microreactors under reaction conditions for the reaction of interest,

simultaneously discharging a reactor effluent from the material-containing microreactors, and

evaluating the at least four materials for catalytic activity for the chemical reaction of interest.

162. A method for evaluating or optimizing process conditions for a chemical reaction of interest, the method comprising

simultaneously supplying one or more reactants to each of four or more microreactors, each of the microreactors comprising a surface defining a reaction cavity having a volume of not more than about 10 μl for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity, and an outlet port in fluid communication with the reaction cavity,

controlling a first set of reaction conditions to be substantially identical in each of the microreactors,

controlling a second set of reaction conditions to be varied between two or more

of the microreactors,

simultaneously discharging a reactor effluent from each of the four or more microreactors to four or more microseparators, each of the microseparators comprising a surface defining a separation cavity for separating at least one component of a reactor effluent, an inlet port in fluid communication with the outlet port of one of the microreactors for receiving the reactor effluent therefrom, and an outlet port in fluid communication with the separation cavity, and

simultaneously discharging the separated effluent from each of the microseparators, and

evaluating the effect of varying the second set of reaction conditions.

163. The method of claim 162 wherein the four or more microreactors are formed in a plurality of laminae and the four or more microseparators are formed in a plurality of laminae.

164. The method of claim 162 wherein the reaction cavity of each of the at least four candidate material-containing microreactors has a volume of not more than about 1 µl.

165. The method of claim 162 wherein the first and second set of reaction conditions are independently selected from the group consisting of temperature, pressure, residence time and flow rate.

166. The method of claim 162 wherein the first and second set of reaction conditions are independently selected from the group consisting of temperature, pressure, and residence time.

167. A method for evaluating or optimizing process conditions for a chemical reaction of interest, the method comprising

simultaneously supplying one or more reactants to each of four or more microreactors of the chemical processing microsystem of claims 1, 7, 14, 20, 32, 38, 40, 45 or 61,

controlling a first set of reaction conditions to be substantially identical in each of the microreactors,

controlling a second set of reaction conditions to be varied between two or more of the microreactors,

simultaneously discharging a reactor effluent from each of the four or more microreactors, and

evaluating the effect of varying the second set of reaction conditions.

168. A manifold for distributing fluids in microfluidic systems, the manifold comprising

a common port adaptable for fluid communication with one or more fluid sources or sinks,

2^n terminal ports adaptable for fluid delivery to or fluid recovery from 2^n microcomponents, n being an integer not less than 2, and

a distribution channel providing fluid communication between the common port and each of the 2^n terminal ports, the distribution channel having a hydraulic radius of not more than about 2.5 mm and comprising 2^n-1 channel sections connected with each other through 2^n-1 binary junctions, each of the 2^n-1 channel sections having at least three access ports serving as the common port, as a connection port for a binary junction, or as a terminal port, the manifold being further characterized by one or more of the features selected from the group consisting of

the 2^n-1 channel sections are linear channel sections,

n is an integer of not less than 6, and

the 2^n microcomponents are arranged in a substantially planar array with a planar density of not less than about 1 microcomponent / cm^2.

169. The manifold of claim 168 wherein (a) one of the channel sections has access ports serving as the common port and as connection ports for two binary junctions, (b) $[2^{n-1}$-2)] of the channel sections have access ports serving as connection ports for three binary junctions, and (c) $[2^{n-1}]$ of the channel sections have access ports serving as a connection port for one binary junction and as two terminal ports.

170. The manifold of claim 168 wherein the microcomponents are microreactors comprising a surface defining a reaction cavity having a volume of not more than about 3 ml for carrying out a chemical reaction, and at least one port in fluid communication with the reaction cavity.

171. The manifold of claim 168 wherein the distribution channel has a conductance that is substantially the same for each of the flow paths between the common port and each of the terminal ports.

172. The manifold of claim 168 wherein the length of a total flowpath between the common port and each terminal port is the same.

173. The manifold of claim 168 wherein the change in pressure between the common port and each terminal port is the same.

174. The manifold of claim 168 wherein the change in pressure between the common port and each terminal port is substantially linear.

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175. The manifold of claim 168 wherein n is not less than 8.

176. The manifold of claim 168 wherein n is not less than 10.

177. The manifold of claim 168 wherein each of the channel sections of the distribution channel are substantially coplanar.

178. A method for providing fluids to or removing fluids from a plurality of microcomponents, the method comprising

simultaneously supplying a fluid to, or discharging a fluid from, each of 2^n microcomponents, n being an integer of not less than 2, the fluid being supplied or discharged through the distribution manifold of claim 168.

179. A microreactor for microscale chemical reactions, the microreactor comprising

a surface defining a reaction cavity for carrying out a chemical reaction, the reaction cavity having a volume of not more than about 10 µl and a geometry defined by ratios of distances X, Y, and Z measured within the reaction cavity along three mutually orthogonal lines having a common point of intersection at a midpoint of the longest line, Z, the X:Z and Y:Z ratios each ranging from about 1:2 to about 1:1,

an inlet port in fluid communication with the reaction cavity for supplying one or more reactants thereto, and

an outlet port in fluid communication with the reaction cavity for discharging one or more reaction products therefrom.

180. The microreactor of claim 179 wherein the volume of the reaction cavity is not more than about 1 μl.

181. The microreactor of claim 179 wherein the X:Z and Y:Z ratios each range from about 2:3 to about 1:1.

182. The microreactor of claim 179 wherein the X:Z and Y:Z ratios each range from about 3:4 to about 1:1.

183. The microreactor of claim 179 wherein the X:Z and Y:Z ratios are each about 1:1.

184. A method for effecting a microscale chemical reaction, the method comprising

supplying one or more reactants for a chemical reaction of interest to a microreactor, the microreactor comprising a surface defining a reaction cavity having a volume of not more than about 10 μl for carrying out a chemical reaction, an inlet port in fluid communication with the reaction cavity for supplying one or more reactants thereto, and an outlet port in fluid communication with the reaction cavity for discharging one or more reaction products therefrom, and

converting the one or more reactants to one or more reaction products in the reaction cavity,

the reactants residing in the reaction cavity under process conditions effective for the chemical reaction of interest for a residence time, τ_{res}, that is longer than the diffusion period, τ_{diff}, for the reaction cavity under such process conditions.

185. The method of claim 184 wherein the microreactor further comprises a catalyst within the reaction cavity for catalyzing the chemical reaction of interest.